THE INFLUENCE OF DRYING TECHNOLOGY ON THE CHEMICAL CONTENT OF *OYSTER* MUSHROOMS (*Pleuropus ostreatus* E.)

Monika Stojanova[1], Igor Ivanovski[1], Marina Todor Stojanova[1], Sandra Milenkovska[1]

Abstract: In the Republic of Macedonia *oyster* mushroom, *Pleurotus ostreatus* E. is widespread. In nature it grows arranged side by side and one above the other. They are light brown in color with a characteristic shape as a shell. Many of them are rich in vitamins and have prominent smell and taste. For consummation it is used fresh, as well as processed. From the processed forms, the widely used is dried mushroom. The mushrooms chemical content has an essential importance for human diet and for the technological process, too. The fresh mushrooms chemical content is important for choosing the technological processes and for products quality properties. The aim of this research was to determine the differences of the chemical content of both fresh and dried *oyster* mushrooms. The quality properties were determined by determining the mechanical and the chemical properties. The research was done in 2013. Drying was made in ventricular drier with heated air. The principle of drying is accurately performed to obtain characteristic odor and appearance of the mushroom. All of determined components have higher values in dried mushrooms, compared with fresh ones. The content of total dry matters is higher in dried mushrooms (93.10%) compared with fresh mushrooms (23.10%). The content of total acids in dry mushrooms is 0.40% and its value in fresh mushrooms is 0.13%. The content of vitamin C in dried mushrooms is 14.10 mg %, but in the fresh ones is 9.20 mg %. The value of mineral matters is 4.50% in dried and 0.90 % in fresh mushrooms. Drying in ventricular drier is fast method which reduces the necessary water quantity, inactivates the enzymes, reduces microorganism's metabolism. This is a basic principle in product conserving and storage for a longer period.

Key words: mushrooms, ventricular drying, chemical content.

Introduction

Oyster mushroom (*Pleuropus ostreatus* E.) is an important edible mushroom which is widespread in the Republic of Macedonia. It is found in temperate forests and is growing arranged side by side and one above the other. This mushroom grows after heavy rains, when the weather will slightly warm, but also in cold periods of the year (Sonali and Randive, 2012; Chang, 1987). It grows in the winter when other mushrooms are rarely encountered. *Oyster* mushroom is saprophyte that grows on logs, fallen trees, and pieces of trees that remain after the cutting of the forest (Shah et al., 2004; Burnett, 1988). *Oyster* mushroom draws very healthy and nutrient needs from the trees that are

[1] Faculty of agricultural sciences and food, Ss. Cyril and Methodius, Blvd. Aleksandar Makedonski bb, Skopje, Republic of Macedonia (stojanova.monika@yahoo.com).

using for growth and development, and these substances favorably affect the human body (Ahmed, 1986; Caglarirmak, 2007).

Oyster mushroom is easily recognized. It has light brown color with a characteristic shape as shell. The meat is white and firm elastic, with a pleasant taste and distinctive smell, very favorable for processing (Bonatti et al., 2004; Khydagi, 1998).

Oyster mushroom can be produced on wheat straw, corn cobs, sawdust, and trunks of deciduous trees. It is best grown on a substrate of pure chopped wheat straw, or with the addition of 10% meadow hay or cut corn cobs (Das and Mukherjee, 2007).

It can be produced and logs of poplar, birch and bone, as well as in logs of deciduous trees - beech and oak. *Oyster* mushroom can be produced throughout the year on a relatively small area in a short cycle (Dundar et al., 2009; Chang and Miles, 2004).

Depending on the strain, *oyster* mushroom can grow at a temperature of 5 - 15°C or 18 - 28°C. During the production takes place in moderate humidity wetting the substrate surface (but not in the fungus). If there is not enough lighting, additional lighting with ultraviolet light is used (12 hours light and 12 hours of darkness).

Oyster mushroom should be picked while it is young and soft. Fruit is growing in waves within 10-14 days. Most fruit has the first and second wave. The total yield is about 20% by weight of the substrate.

According to the nutritional value *oyster* mushroom takes place between vegetables and meat, and it is closer to the meat (Eswaran and Ramabadran, 2000). This mushroom is rich in vitamins, has prominent smell and taste and often reaches sizes up to 20 cm in diameter.

The beneficial effects of *oyster* mushrooms have been discovered by the Chinese, where today commonly used is dried or powdered, and Europeans began to use in the end of the last century.

In its composition *oyster* mushroom contains vitamins: B, D, C, K, proteins, minerals - iodine, selenium, sodium, potassium, zinc, phosphorus, and iron (Mattila et al., 2001; Patil et al., 2010). Additionally it contains chlorophyll which accelerates the regeneration of cells, and has fiber that bind and ejecting waste products from the body (Bano, 1976; Wang et al., 2001).

For consummation, it is used both in fresh and processed form. From the processed form, mainly it is used as dried (Oseni et al., 2012).

The chemical composition of the mushrooms has an essential importance for human nutrition as well as for choosing of technological method for processing. It has an influence on the final products (Sun and Jian-Jun, 1989; Turner, 1988).

The aim of this research was to determine the differences in the chemical composition between fresh and dried *oyster* mushrooms.

Material and methods

In this research, as a work materials were used fresh and ventricular dried *oyster* mushrooms. This kind of mushrooms, in the Republic of Macedonia, grows in very small quantities. The mushrooms for this research were picked from Baba Mountain. *Oyster* mushrooms were picked when the cap was approximately 70 percent open, i.e. when the mushroom caps were still slightly curled under.

The quality properties of the analyzed mushrooms were determined with determining the mechanical and the chemical properties. Research was made in 2013.

The mechanical properties were determined only in fresh *oyster* mushrooms. From the mechanical properties were determined the diameter of the mushroom cap and the length of the mushroom stalk.

The chemical content of fresh and dried mushrooms was determined. The drying was made in the ventricular drier with heated air. The principle of drying was accurately performed to obtain characteristic odor and appearance of the mushroom.

The following chemical properties of fresh and dried *oyster* mushrooms were determined:

- Content of total dry matter - determined by drying the material in dryer at a temperature of 105°C;
- Moisture content – determined by calculation that 100 % will be deducted % of total dry matter;
- Content of vitamin C - determined by the Thilmans method based on the redox reaction between L-ascorbic acid and organic color 2.6 dichlorophenolindophenol;
- Total acid content - determined by the method of neutralization with 0.1 M NaOH solution in the presence of the indicator 1 % solution of phenolphthalein indicator;
- Content of total carbohydrates - determined by HPLC method;
- Content of mineral matter (ash) - determined with material burning at a temperature of 500 °C;
- Content of nitrogen (N) - determined using Kjeldhl method (Sarić et al., 1989);
- Content of phosphorus (P_2O_5) - determined by using atomic emission spectrometry with inductively coupled plasma (ICP - AEC) (Sarić et al., 1989);
- Content of potassium (K_2O) - determined by incineration of the material with concentrated H_2SO_4 and plamenphotometer (Sarić et al., 1989);
- Content of calcium (SAT) - determined by using atomic emission spectrometry with inductively coupled plasma (ICP - AEC) (Sarić et al., 1989);
- Content of magnesium (Mg) - determined by applying atomic; emission spectrometry with inductively coupled plasma (ICP - AEC) (Sarić et al., 1989);
- Proteins – determined with calculation when the % N is multiplying with coefficient 6.25.

In the dried *oyster* mushrooms were made two pretreatments, and three variants were getting: variant M1 – control variant; variant M2 – where the pretreatment was made with 2% solution of ascorbic acid for 5 minutes; variant M3 – where the pretreatment was made with 3% solution of potassiummetabisulphite for 5 minutes. The content of mineral matters nitrogen, phosphorus, potassium, calcium and magnesium was analyzed only in the variants of dried *oyster* mushrooms.

Results and discussion

The mechanical and the chemical content are specific for each kind of mushrooms. The mechanical properties are basic requirement for cost-effective production of mushrooms. Size is an important characteristic for each mushroom kind. By analyzing

the mechanical properties, is determined the weight ratio of separate parts of the mushrooms (cap diameter and stalk length) in percentage (Mattila et al., 2001; Caglarirmak, 2007). Chemical composition of the mushrooms means the content of all ingredients in the mushroom including the water.

The mechanical properties were determined with measuring of 50 *oyster* mushrooms. According to the results of measuring was determined that the average diameter of the mushroom cup is 8.60 cm and the average length of the mushroom stalk is 4.10 cm.

The results of the chemical composition of *oyster* mushrooms are shown in the next tables.

Tabela 1. Hemiski sastav sveze gljive bukovaca
Table 1. Chemical content of fresh oyster mushrooms

Komponente *Components*	Sveze bukovace *Fresh oyster mushrooms*
Ukupna voda (%) *Total water (%)*	76.10
Ukupne suve materija (%) *Total dry matters (%)*	23.10
Ukupne kiseline (%) *Total acids (%)*	0.13
Vitamin C mg/100g *Vitamin C mg/100g*	9.20
Mineralna materija (%) *Mineral matters (ash) (%)*	0.90
Ukupne jaglehidrate (%) *Total carbohydrates (%)*	5.00

From the data shown in Table 1 and Table 2, can be concluded that the content of total water is higher in the fresh mushrooms where its value is 76.10%, and in the dried mushrooms the highest content of total water has variant M3 (7.20%). The content of total dry matters is in correlation with the content of total water and its value is 23.10% in the fresh i.e. 93.10% in the variant M1 from dried *oyster* mushrooms. Fresh *oyster* mushrooms have lower content of total acids (0.13%) compared with dried mushrooms from the variant M1 (0.40%). The vitamin C in fresh mushrooms is presented with 9.20 mg/100g and in dried *oyster* mushrooms the content of vitamin C is the highest in variant M2 (14.10 mg/100g) where the pretreatment was made with 2% solution of ascorbic acid. Fresh *oyster* mushrooms contain 0.90% mineral matters, compared with dried mushrooms from the variant M1, where its content is 4.50%. The content of total carbohydrates in the fresh mushrooms is lower (5.00%), compared with dried *oyster* mushrooms from the variant M1 (7.80%). The content of mineral matters: nitrogen (2.70%), phosphorus (1.40%), calcium (3.90%) and magnesium (2.50%) is the highest in dried *oyster* mushrooms from the variant M1. The content of potassium (1.35%) is the highest in dried mushrooms from the variant M3, where the pretreatment was made with 3% solution of potassiummetabisulphite. The content of proteins is in correlation

with the nitrogen content, and its value is the highest in dried *oyster* mushrooms from the variant M1 (16.96%).

Tabela 2. Hemiski sastav susene gljive bukovace po varijantama
Table 2. Chemical content of dried oyster mushrooms per variants

Komponente *Components*	**M1**	**M2**	**M3**
Ukupna voda (%) *Total water (%)*	6.90	6.95	7.20
Ukupne suve materije (%) *Total dry matters (%)*	93.10	93.05	92.80
Ukupne kiseline (%) *Total acids (%)*	0.40	0.39	0.37
Vitamin C mg/100g *Vitamin C mg/100g*	14.10	14.50	13.80
Mineralna materija (%) *Mineral matters (ash) (%)*	4.50	4.30	4.00
Ukupne jaglehidrate (%) *Total carbohydrates (%)*	7.80	6.60	7,00
N (%)	2.70	2,10	1.95
P (%)	1.40	1,05	1.10
K (%)	1.20	1.15	1.35
Ca (%)	3.90	3.75	3.60
Mg (%)	2.50	2.38	2.40
Proteini (%) *Proteins (%)*	16.96	13.19	12.25

From the presented data can be concluded that *oyster* mushrooms are suitable for ventricular drying, because their chemical content after drying does not change in negative direction. From this three variant of dried mushrooms, the variant M1 which has no pretreatment, is characterized with the best chemical content. Because of that, this variant is recommended for consummation, as food with rich chemical content and excellent nutritive values.

Conclusion

Based on this research and the results for determining the influence of ventricular drying technology on the chemical composition of *oyster* mushrooms, the following conclusions can be made:

- The chemical content of the mushrooms has an essential importance for human nutrition as well as for choosing of technological method for processing;
- In all of the variants of ventricular dried *oyster* mushrooms is determined higher content of all parameters compared with fresh *oyster* mushrooms;
- The content of dry matters is lower in fresh mushrooms, where its value is 23.10%, compared with dried mushrooms, where the highest content of dry matters has the variant M1 (93.10);

- The content of vitamin C is the highest in the variant M2 (14.10%), compared with fresh mushrooms (9.20%);
- Dried *oyster* mushrooms from the control variant M1, have the highest content of nitrogen, phosphorus, calcium, magnesium and proteins;
- Dried *oyster* mushrooms from the variant M1, which have no pretreatment, are characterized with the best chemical properties;
- Ventricular drying is in the initial stage in our country. With the introduction of ventricular dryers in general practice will increase the income of farmers, production, employment and foreign exchange inflow into the country.

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